

What is claimed is:

1. An imaging optical system for forming an image of an object, comprising:
a first lens unit located at a most object-side position; and
at least one of second lens units interposed between the first lens unit and the image,

5 at least one of the second lens units being moved along an optical axis,
wherein the first lens unit includes, in order from an object side:
at least one lens with negative refracting power;
a deformable mirror; and
at least one lens with positive refracting power, and
10 focusing is performed by deformation of the deformable mirror.

2. An imaging optical system according to claim 1, further comprising lens units arranged adjacent to an object side and an image side of the deformable mirror and satisfying one of the following conditions:

$$0.1 < d1 / fw < 10.0$$

$$0.1 < d2 / fw < 10.0$$

5 where $d1$ is a distance between a lens unit placed adjacent to the object side and the deformable mirror, $d2$ is a distance between a lens unit placed adjacent to the image side and the deformable mirror, and fw is a focal length of the imaging optical system at a wide-angle position.

3. An imaging optical system according to claim 1, satisfying the following condition:

$$0.2 < | fG1 / fw |$$

5 where $fG1$ is a focal length of the first lens unit and fw is a focal length of the imaging optical system at a wide-angle position.

4. An imaging optical system according to claim 1, wherein at least one of the lens units moved along the optical axis satisfies the following condition:

$$0.1 < | f_{Gm} / f_w |$$

where f_{Gm} is a focal length of the lens unit moved along the optical axis and f_w is a focal length of the imaging optical system at a wide-angle position.

5. An imaging optical system according to claim 1, wherein the first lens unit has a third lens unit located on an image side of the deformable mirror and satisfies the following condition:

$$0.1 < | f_{G1p} / f_w |$$

where f_{G1p} is the focal length of the third lens unit and f_w is a focal length of the imaging optical system at a wide-angle position.

6. An imaging optical system according to claim 1, wherein a shape of the deformable mirror can be changed within a preset limit to satisfy one of the following conditions in one state within the preset limit:

$$| C_4 \times f_w | < 0.2$$

$$| C_6 \times f_w | < 0.2$$

where C_4 is a coefficient in a term of X^2 where a profile of a reflecting surface of the deformable mirror is expressed by a polynomial of X and Y , C_6 is a coefficient in a term of Y^2 of the polynomial, and f_w is a focal length of the imaging optical system at a wide-angle position.

7. An imaging optical system according to claim 1, wherein the deformable mirror is placed so as to satisfy the following condition:

$$35^\circ < \theta < 105^\circ$$

where θ is a sum of an angle of incidence of an axial chief ray on the deformable mirror and an angle of emergence of the axial chief ray from the deformable mirror.

8. An imaging optical system according to claim 1, wherein at least one optical surface constituting the imaging optical system is shift-decentered in a direction nearly perpendicular to an axial chief ray to satisfy the following condition:

$$|\delta / fw| < 1.0$$

5 where δ is the amount of shift decentration of the optical surface and fw is a focal length of the imaging optical system at a wide-angle position.

9. An imaging optical system according to claim 1, wherein at least one optical surface constituting the imaging optical system is tilt-decentered, with an axis nearly perpendicular to the axial chief ray as a center, to satisfy the following condition:

$$|\epsilon| < 5.0 \text{ (deg)}$$

5 where ϵ (deg) is the amount of tilt decentration of the optical surface.

10. An imaging optical system according to claim 1, wherein the first lens unit has negative refracting power; the second lens units interposed between the first lens unit and the image include a fourth lens unit with positive refracting power, a fifth lens unit with negative refracting power, a sixth lens unit with positive refracting power, and a seventh lens unit; the second lens units moved along the optical axis are the fourth lens unit and the sixth lens unit; and each of the fourth lens unit and the sixth lens unit is moved independently.

11. An imaging optical system according to claim 1 or 10, wherein each of the second lens units moved along the optical axis has at least two relatively decentered lenses.

12. An imaging optical system according to claim 1 or 10, further comprising a stop, the stop remaining fixed when a magnification of the optical system is changed.

13. An imaging optical system according to claim 1 or 10, satisfying the following condition:

$$| fG3 / fw | < 15.0$$

where $fG3$ is a focal length of the fifth lens unit and fw is a focal length of the imaging optical system at a wide-angle position.

14. An imaging optical system according to claim 1, wherein the first lens unit has negative refracting power.

15. An imaging optical system according to claim 1, further comprising a variable mirror instead of the deformable mirror.

16. An imaging optical system comprising, in order from an object side:

a first lens unit with negative refracting power;

a second lens unit with positive refracting power;

a third lens unit with negative refracting power;

a fourth lens unit with positive refracting power; and

a fifth lens unit,

the second lens unit and the fourth lens unit being moved dependently along an optical axis and satisfying one of the following conditions:

$$0.1 < fG2 / fw$$

$$0.1 < fG4 / fw$$

where $fG2$ is a focal length of the second lens unit, $fG4$ is a focal length of the fourth lens unit, and fw is a focal length of the imaging optical system at a wide-angle position.

17. An imaging optical system according to claim 16, wherein the first lens unit has at least one reflecting optical element.

18. An imaging optical system according to claim 16, further comprising lens units located adjacent to an object side and an image side of the reflecting optical element, the lens units satisfying one of the following conditions:

$$0.1 < D1 / fw < 10.0$$

$$0.1 < D2 / fw < 10.0$$

where D1 is a distance between a lens unit placed adjacent to the object side and the reflecting optical element and D2 is a distance between a lens unit placed adjacent to the image side and the reflecting optical element.

19. An imaging optical system according to claim 10 or 14, satisfying the following condition:

$$0.2 < | fG5 / fw |$$

where fG5 is a focal length of the fifth lens unit and fw is a focal length of the imaging optical system at a wide-angle position.

20. An imaging optical system comprising at least one lens unit moved along an optical axis when a magnification of the optical system is changed, the lens unit having at least two relatively decentered lenses.

21. An imaging optical system according to claim 20, further comprising at least one variable optical-property element.

22. An imaging optical system according to claim 21, wherein the variable optical-property element is a variable mirror.

23. An imaging optical system according to claim 22, wherein the variable mirror is a deformable mirror.

24. An imaging apparatus comprising:

an imaging optical system; and

an image sensor,

the imaging optical system comprising

5 a first lens unit located at a most object-side position; and

at least one of second lens units interposed between the first lens unit and the image,

at least one of the second lens units being moved along an optical axis,

wherein the first lens unit includes, in order from an object side:

10 at least one lens with negative refracting power;

a deformable mirror; and

at least one lens with positive refracting power, and

focusing is performed by deformation of the deformable mirror.

25. An imaging apparatus according to claim 24, wherein the image sensor is tilt-decentered, with an axis nearly perpendicular to an axial chief ray as a center, to satisfy the following condition:

$$|\epsilon'| < 5.0 \text{ (deg)}$$

5 where ϵ' (deg) is the amount of tilt decentration of the image sensor.